



Distribution A: Approved for Public Release



TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

Power and Energy Innovation Workshop

Dr. Peter Schihl

TARDEC Ground Vehicle Propulsion and Mobility Laboratory

Report Documentation Page				Form Approved OMB No. 0704-0188	
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE 07 JUL 2009		2. REPORT TYPE N/A		3. DATES COVERED -	
4. TITLE AND SUBTITLE Power and Energy Innovation Workshop				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S) Peter Schihl				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) US Army RDECOM-TARDEC 6501 E 11 Mile Rd Warren, MI 48397-5000				8. PERFORMING ORGANIZATION REPORT NUMBER 19991RC	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S) TACOM/TARDEC	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S) 19991RC	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release, distribution unlimited					
13. SUPPLEMENTARY NOTES Presented at the Power and enerby Innovation Workshop, 7-8 July 2009, Sterling Heights, MI, USA, The original document contains color images.					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT SAR	18. NUMBER OF PAGES 14	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

- **Introduction of Co-Chairman**
 - Dr. Pete Schihl, TARDEC
 - Chief Technologist, Ground Vehicle Propulsion and Mobility Laboratory
 - COL R. Craig Effinger, TRADOC
 - Chief, Science and Technology Division, Army Capabilities Integration Center (ARCIC)

- **Thank you for coming to our workshop**
 - Military Ground and Aerial Vehicle OEMs
 - Military suppliers
 - National Labs
 - Universities
 - Army Labs/Organizations
 - Air Force
 - Automotive OEM and suppliers
 - Various SME consultants

- **BRTRC**
- **Booz-Allen-Hamilton**
- **Alion**
- **Sterling Inn**

Disclaimer: Reference herein to any specific commercial company, product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or the Department of the Army (DoA). The opinions of the authors expressed herein do not necessarily state or reflect those of the United States Government or the DoA, and shall not be used for advertising or product endorsement purposes.**

- **Objective:** To articulate required power and energy capabilities and outline efficient Soldier, Vehicle and Installation technologies that will reduce overall energy requirements for the future force in order to optimize effectiveness.
- **Deliverable:** TARDEC, ARCIC* and HQDA G-4 will deliver a whitepaper that outlines the scope of the Army's power and energy needs and technology areas that will be explored to meet those needs in the near, mid, and far term (i.e. 2014, 2024, and 2030).

- **Aid the Army in developing the complexion of its future R&D thrust areas as related to Power and Energy mid- and long-term strategies**
- **Provide valuable input for risk assessment associated with various potential technologies**
- **Interact with Army representatives to exchange ideas – two way street**



Power and Energy: Interesting Observations



- Warm-up H₂O one degree C ~ 4000 J
- Lightning strike ~ 1 GJ (10 m-sec duration!)
- Yoda 'force pulling' Luke Skywalker's ship out of the swamp of Dogaboh up and onto the ground ~ 0.15 MJ
- **Earth's daily solar energy receipt is 10¹⁸ Watt-hours**
 - o 3.6 x 10¹⁴ MJ (~ 400 W/m²)
 - o with 10% conversion – 3.6 x 10¹³ MJ (~ 40 W/m²)
 - o United States portion ~ 5.6 x 10¹¹ MJ (1.7%)
- **Hercules Recovery Vehicle: AVDS 1790 diesel engine – 750 kW**
 - o operating 1 hour produces 260 MJ
 - o throughout a 400 hour durability test – 5 x 10⁴ MJ
- **Fermi II Nuclear Power plant ~ 10³ MW**
 - o Southeastern Michigan total demand ~ 10⁴ MW
 - o Sun power in U.S. 4 x 10⁹ MW (SE Michigan ~ 4 x 10⁶ MW)

- **Dr. Paul Rogers**
 - o TARDEC Executive Director, Research

- **COL Paul Roege (retired)**
 - o ARCIC support contractor to COL Effinger

Workshop Focus Areas:

- Soldier (Sensors/Weapons)
- Vehicles (Ground)
- Vehicles (Aerial)
- Installation (Fixed and Expeditionary)

Workshop Overarching Guidance:

- Focus near, mid and far term (2014, 2024, & 2030)

3rd Day Activities:

- Validate scribe notes
- Develop outline for white paper

Vehicle (Ground): Co-Chair – Pete Schihl, Ernie Schwarz (TARDEC)
Co-Chair – COL Michael A. Kriz (CASCOM)

Sub-Sessions

- **Alt Power Sources:** Erik Kallio
— *Wind, Solar, Fuel Cells, Storage*
- **Alt Fuels:** Patsy Muzzell
- **Waste Energy Conversion:** Gus Khalil
- **Nuclear:** Joel King/ Herb Dobbs
- **Alternative Propulsion:** Schihl / Schwarz
- **Integration (Soldier/Grid):** Khalil / Schihl

Vehicle (Aerial): Co-Chair – Ming Lau (AMRDEC)
Co-Chair – Glenn Harrison (TRADOC)

Sub-Sessions

- **Hybrid Propulsion – *Bert Smith***
- **Alternative Fuels – *Pat Muzzell***
- **More Electric – *Bert Smith***
- **Advanced Propulsion – *Kevin Kerner***
- **Alternative Engine Cycles/Configurations – *Kevin Kerner***

**Installation: Co-Chair – Frank Holcomb (CERL), Harold Sanborn (NAC)
Co-Chair – LTC Larry Glidewell (TRADOC)**

Sub-Sessions

- **Renewable Energy & Thermal/Electrical Energy Storage Opportunities**
- **Conservation/Demand Reduction/Efficiency**
- **Nuclear Energy/Spaced Based Solar**
- **Micro-grid/Islanded Grids**
- **Research Gaps - TRADOC Modular Force Ideas**
- **Installations & FOB Environmental Footprint - Train as Fight**
- **Finance/Contracts/Policy (Installation Centric)**

**Soldier: Co-Chair – Steve Slane (CERDEC), Scott Feldman (NATICK)
Co-Chair – Ms. Cheryl Bruhn (TRADOC)**

Sub-Sessions

- **Energy Storage:** Steve Slane
- **Energy Harvesting:** Steve Tucker
- **Fueled Systems:** JJ Kowal
- **Nuclear:** Steve Slane
- **Integration (Vehicle/Grid):** Steve Slane

	DAY ONE				DAY TWO			
TIME	Soldier	Ground Vehicles	Installation	Aerial Vehicles	Soldier	Ground Vehicles	Installation	Aerial Vehicles
8 – 9 am	Briefings on chosen subject areas – fossil fuel energy and alt mobility transportation; small energy and power devices; nuclear Two is probably best to allow for Army interaction – COL Effinger, Dr. Schihl, COL Roege, Co-Chairs;				Fueled Systems	Nuclear (electric)	Micro-grid/ Islanded Grids	Advanced Propulsion
9 – 10 am					Fueled Systems	Nuclear (electric)	Research Gaps - TRADOC Modular Force Ideas	Advanced Propulsion
10 – 10:30	BREAK	BREAK	BREAK	BREAK	BREAK	BREAK	BREAK	BREAK
10:30 – noon	Energy Storage (disposable)	Alt energy	Renewable Energy & Thermal/Electrical Energy Storage Opportunities	Hybrid Propulsion	Nuclear	Alt. Propulsion	Installations & FOB Env Footprint - Train as Fight	Alt Engine Cycles / Configurations
LUNCH								
1 – 3 pm	Energy Storage (rechargeable)	Alt energy - Fuels	Conservation/ Demand Reduction/Eff.	Alt energy - Fuels (Combined with Ground Veh)	Integration into 'grid'	Integration into 'grid'	Finance/Contracts/Policy	Alt Engine Cycles / Configurations
3 – 3:30 pm	BREAK	BREAK	BREAK	BREAK	BREAK	BREAK	BREAK	BREAK
3:30 – 5:00 pm	Energy Harvesting	WEC	Nuclear Energy/Space Based Solar	More Electric	Wrap-up	Wrap-up	Wrap-Up	Wrap-Up

- 'round table' style format lead by each technical session chairman and facilitator based on discussion outlines
- Discussion outlines emailed to attendees last week; hardcopies available at the badge pick-up desk
- Focus is to discuss technologies in the near, mid, and far term as related to the specific technical session
 - An opportunity to provide technical input to key Army personnel for influencing future R&D decisions
 - We are looking for honest input; participant based marketing is highly discouraged in this forum
- Each room will include a scribe for capturing key important discussion items